

### **CLAIMS**

1. Method for determining the operating parameters of single fuel cells or of short stacks of fuel cells, preferably medium- or high-temperature fuel cells, **characterized in that** in parallel with the fuel cell plane planar heating elements are pressed against one or preferably both exterior surfaces of the single cell or the short stack, and that a predetermined temperature  $T_H$  may be set for the fuel cell by means of the heating elements and that at least one operating parameter of the fuel cell is measured as a function of the chosen temperature  $T_H$ .
2. Method according to claim 1, **characterized in that** a temperature curve or a temperature gradient over time is applied under which different operational states of the fuel cell, such as start-up, change of load or continuous operation, are simulated.
3. Method according to claim 1 or 2, **characterized in that** by partitioning of the planar heating elements into individual, separately controllable segments a two-dimensional temperature distribution or temperature gradient can be applied.
4. Method according to any of claims 1 to 3, **characterized in that** by a cyclical application of extreme temporal and/or areal temperature gradients an accelerated aging process of the fuel cell is simulated.
5. Method according to any of claims 1 to 4, **characterized in that** electrochemical parameters of the fuel cell, which are obtained from simulation models or model computations, are compared to measured values of these parameters and the simulation models are adapted accordingly.
6. Method according to any of claims 1 to 5, **characterized in that** the temperature  $T_Z$  in the fuel cell and the temperature  $T_H$  in the heating element or in the individual heating element segments are measured and the temperature  $T_H$  in the heating element is regulated in such a way that the heating power of an adjacent neighbour cell is simulated.

7. Method according to any of claims 1 to 6, **characterized in that** the temperature  $T_z$  of the fuel cell is additionally set or varied by applying or removing exterior insulating elements or by active cooling elements.
8. Device (1) for determining the operating parameters of single cells (2) or of short stacks (10) of fuel cells, preferably of medium- or high-temperature fuel cells, **characterized in that** in parallel with the fuel cell plane ( $\varepsilon$ ) planar heating elements (4) are placed at one or preferably both exterior surfaces (3) of the single cell (2) or the short stack (10), which heating elements are connected to a control and evaluation unit (5) for setting a predetermined temperature.
9. Device according to claim 8, **characterized in that** temperature sensors (9, 9') are located in each single cell (2) and in the heating elements (4), which sensors are connected to a control loop in the control and evaluation unit (5).
10. Device according to any of claims 8 or 9, **characterized in that** each of the heating elements (4) is partitioned into multiple, separately controllable segments (4a, 4b, 4c, ...).
11. Device according to any of claims 8 to 10, **characterized in that** the heating elements (4) or their segments (4a, 4b, 4c, ...) are provided with detachable, exterior insulating elements (11, 11').
12. Device according to any of claims 10 to 11, **characterized in that** thermally insulating elements (13) are placed between the heating element segments (4a, 4b, 4c, ...) located at an exterior surface (3) of the single cell (2).
13. Device according to any of claims 11 or 12, **characterized in that** the exterior insulating elements (11, 11') and/or the insulating elements (13) located between the heating element segments (4a, 4b, 4c, ...) are provided with active cooling elements (12), for instance heat exchangers for a cooling medium.
14. Device according to any of claims 8 to 13, **characterized in that** a thin thermally insulating intermediary layer (14) is placed between the exterior

surfaces (3) of the single cell (2) and the heating elements (4) or heating element segments (4a, 4b, 4c, ...).

15. Device according to claim 14, **characterized in that** a current collector (17) with areally distributed contact sites is located in the insulating intermediary layer (14).
16. Device according to claim 15, **characterized in that** the current collector (17) is partitioned into a number of separately contacted segments (17a, 17b, 17a', 17b').
17. Device according to any of claims 8 to 16, **characterized in that** a clamping mechanism (6) is provided for pressing the heating elements (4) against the exterior surfaces (3) of the single cell (2) or the short stack (10) and/or against the exterior insulating elements (11) and/or the thermally insulating intermediary layer (14).
18. Device according to claim 17, **characterized in that** the hermetic seal for the gas connections and the electrical connections of the single cell (2) or the short stack (10) are provided by means of the pressure exerted by the clamping mechanism (6).
19. Device according to any of claims 8 to 18, **characterized in that** the control and evaluation unit (5) comprises means for determining at least the temperature, the current and voltage values, the composition of the process gases, the pressure of the process gases, and the useful life of the fuel cell.
20. Method for cooling hot process gases, which arise in the operation of fuel cells or the testing of fuel cell system components, such as reformers, mixing and conditioning systems or catalysers, in a fuel cell testing station, **characterized in that** the hot process gases are fed into at least one heat exchanger unit to lower the temperature in the process gas before entry of the process gas into an exhaust vent of the testing station, and that the waste heat of the heat exchanger unit is carried off with the ambient air flowing into the exhaust vent.

21. Method according to claim 20, **characterized in that** the heat exchanger unit is designed as an air/gas heat exchanger and is directly cooled by the ambient air flowing into the exhaust vent.
22. Method according to claim 20, **characterized in that** the heat exchanger unit is designed as a coolant/gas heat exchanger and that a cooling unit through which the coolant flows is cooled by the ambient air flowing into the exhaust vent.
23. Method according to any of claims 20 to 22, **characterized in that** a surplus of the ambient air is provided for diluting the process gases.
24. Method according to any of claims 20 to 23, **characterized in that** the waste gas in the exhaust vent is fed into a heat recovery unit.
25. Device for cooling hot process gases, which arise in the operation of fuel cells (102) or the testing of fuel cell system components, such as reformers (113), mixing and conditioning systems (103) or catalysers, in a fuel cell testing station (101), **characterized in that** at least one heat exchanger (106, 106') is located in the hot process gas flow (105), which lowers the entry temperature of the process gas before it enters an exhaust vent (107), and that a device for cooling the heat exchanger by means of the ambient air (110) flowing into the exhaust vent (107) is provided.
26. Device according to claim 25, **characterized in that** the heat exchanger is designed as an air/gas heat exchanger (106'), which is located in or at the inlet of an exhaust hood (108) of the exhaust vent (107).
27. Device according to claim 25, **characterized in that** the heat exchanger is designed as a coolant/gas heat exchanger (106), which is connected to a cooling unit (112) located in the exhaust vent (107) via a coolant circulating in a coolant loop (111).
28. Device according to claim 27, **characterized in that** an electrical load (117) connected to the fuel cell (102) or a fuel cell component, which has to be cooled, is connected to a cooling unit (112, 112') in the exhaust vent (107) via a cooling loop (118).

29. Device according to any of claims 25 to 28, **characterized in that** a catalyser (114) and/or a condensate or water separator (115) is positioned in the exhaust vent (107).
30. Fuel cell stacks (201) of medium- or high-temperature fuel cells, which are provided with clamping elements (205) acting on both ends (207) of the fuel cell stack (201) in order to compensate the interior operating pressure and/or hermetically seal the individual fuel cells (202) against each other, **characterized in that** a thermally insulating element (208) transmitting the clamping force is placed between the ends (207) of the fuel cell stack (201) and the respective clamping element (205).
31. Fuel cell stack (201) according to claim 30, **characterized in that** the sides (209) of the fuel cell stack (201) are provided with an exterior insulation (210) detached from the clamping elements (205).
32. Fuel cell stack (201) according to claim 31, **characterized in that** the exterior insulation (210) of the stack (201) laterally embraces the two insulating elements (208) at the stack ends.
33. Fuel cell stack (201) according to any of claims 30 to 32, **characterized in that** at least one of the thermally insulating elements (208) at the stack ends is provided with openings (211) for the passage of inlet and outlet pipes (212, 213) for the process gases involved in the operation of the fuel cells (202).
34. Fuel cell stack (201) according to any of claims 31 to 33, **characterized in that** further fuel cell components, such as high-temperature heat exchangers (216), reformers (217) and/or burners, are contained in a space formed by the exterior insulation (210) and the insulating elements (208) at the stack ends.
35. Fuel cell stack (201) according to any of claims 30 to 34, **characterized in that** the clamping elements (205) are held under tension against each other by tensioning screws (206), with at least one clamping element (205) being spring-loaded by spring elements (214), preferably helical springs, which are located outside the insulation (208, 210) of the fuel cell stack (201).

36. Fuel cell stack (201) according to any of claims 30 to 35, **characterized in that** the thermally insulating elements (208) and, if present, the exterior insulation (210) are made of porous, ceramic material, for instance bound pyrogenic silicic acid.
37. Fuel cell stack (201) according to any of claims 30 to 35, **characterized in that** the essentially pressure-resistant, thermally insulating elements (208) consist of a metallic grid or supporting structure.
38. Fuel cell stack (201) according to any of claims 35 to 37, **characterized in that** the clamping elements (205) and the tensioning screws (206) form a mechanical frame, which functions as a housing and serves as an interface (215) for the electrical connections.
39. Fuel cell stack (201) according to any of claims 30 to 38, **characterized in that** the fuel cell stack (201) comprises solid oxide fuel cells (SOFC) or molten carbonate fuel cells (MCFC).